

# Coordination Compounds

## Question1

When 100 mL of 0.2 M solution of  $\text{CoCl}_3 \cdot x\text{NH}_3$  is treated with excess of  $\text{AgNO}_3$  solution,  $3.6 \times 10^{22}$  ions are precipitated. The value of  $x$  is  $(N = 6 \times 10^{23} \text{ mol}^{-1})$

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Options:

A.

5

B.

6

C.

4

D.

3

**Answer: B**

**Solution:**

Moles of ions precipitated.

$$n_{\text{ions}} = \frac{\text{Number of ions}}{\text{Avogadro's number}} = \frac{3.6 \times 10^{22}}{6 \times 10^{23}}$$

$$n_{\text{ions}} = 0.06 \text{ mol}$$

$$n_{\text{complex}} = \text{Molarity} \times \text{Volume} = 0.2 \times 0.1 = 0.02 \text{ mol}$$



Number of  $\text{Cl}^-$  ions per complex units,

$$Y = \frac{\text{Moles of precipitated ions}}{\text{Moles of complex}} = 3$$

The complex is  $[\text{Co}(\text{NH}_3)_x \text{Cl}_{3-y}] \text{Cl}_y$ .

Coordination number of Co = 6.

$$x = 6$$

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## Question2

Which one of the following is not an ambidentate ligand?

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**Options:**

A.

CN

B.

$\text{SCN}^-$

C.

$\text{SO}_4^{2-}$

D.

$\text{NO}_2^-$

**Answer: C**

**Solution:**

An ambidentate ligand is a ligand that can coordinate to a central metal atom through two different donor atoms, but not at the same time.  $\text{SO}_4^{2-}$  is a bidentate ligand.

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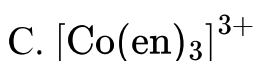
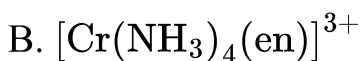
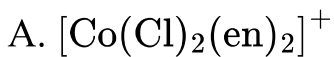


## Question3

Which one of the following complex ions has geometrical isomers?

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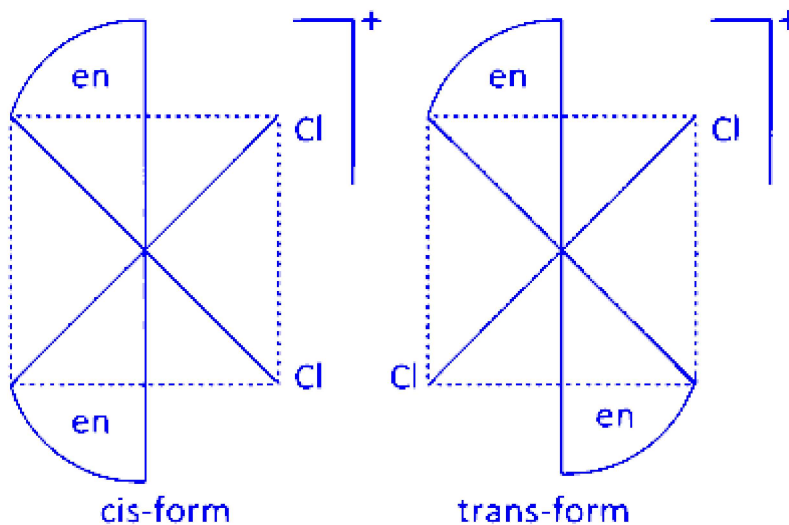
Options:



**Answer: A**

**Solution:**

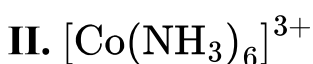
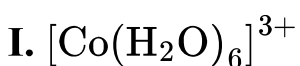
$[\text{Co}(\text{Cl}_2)(\text{en})_2]^+$  ion has geometrical isomers.

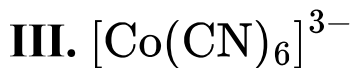


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## Question4

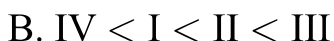
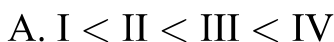
Arrange the following in increasing order of their crystal field splitting energy





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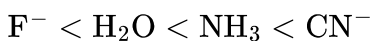
Options:



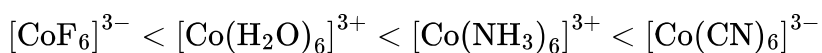
**Answer: B**

**Solution:**

The correct order is  $\text{IV} < \text{I} < \text{II} < \text{III}$  CFSE is higher when the complex contains strong ligand. According to spectrochemical series, the order of field strength is



Hence, the correct order is

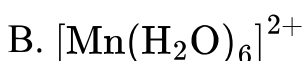
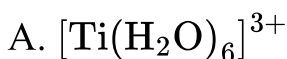


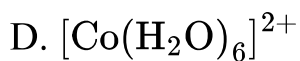
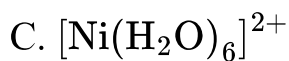
### Question5

**In which of the following ions the spin only magnetic moment is lowest?**

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Options:





**Answer: A**

### Solution:

Among the given ions the spin only magnetic moment is least for  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ .

The spin only magnetic moment is given by

$$\mu_s = \sqrt{n(n+2)} \text{ (where, } n \text{ is number of unpaired electrons.)}$$

For  $\text{Ti}^{3+}$  the number of unpaired electron is 1 which is

$$\mu_s = \sqrt{1(1+2)} = \sqrt{3}\text{BM}$$

While for  $\text{Mn}^{2+}$  number of unpaired electron is 5 .

$$\mu_s = \sqrt{5(5+2)} = \sqrt{35}\text{BM}$$

For  $\text{Co}^{2+}$ ,  $n = 3$

$$\mu_s = \sqrt{3(3+2)} = \sqrt{15}\text{BM}$$

For  $\text{Ni}^{2+}$ ,  $n = 2$

$$\mu_s = \sqrt{2(2+2)} = \sqrt{8}\text{BM}$$

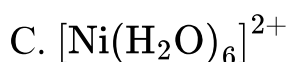
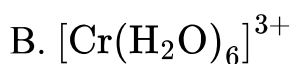
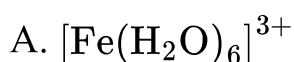
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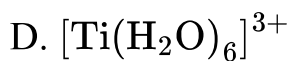
## Question6

Identify the complex ion with electronic configuration  $t_{2g}^3 e_g^2$ .

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**Options:**





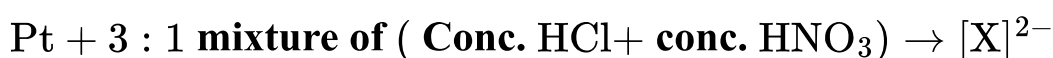
**Answer: A**

## Solution:

As the ligand is same in all the given compounds, thus, the species with 5 unpaired electrons will have  $t_{2g}^3 e_g^2$  electronic configuration. Among the given options  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  has five unpaired electrons as Fe is present in +3 oxidation state.

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## Question 7



What is the oxidation state of Pt in  $[\text{X}]^{2-}$  complex ion ?

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Options:

A. +2

B. +3

C. +4

D. +6

**Answer: C**

## Solution:

When platinum (Pt) is treated with aqua regia (a mixture of concentrated hydrochloric acid and concentrated nitric acid in a 3:1 ratio), it forms a chloro complex ion. The reaction of platinum with this mixture typically produces  $[\text{PtCl}_6]^{2-}$ .

The oxidation state of platinum in the  $[\text{PtCl}_6]^{2-}$  complex ion can be determined as follows:

Let's assume the oxidation state of Pt is  $x$ . Each chloride ion ( $\text{Cl}^-$ ) has a charge of  $-1$ . Since there are six chloride ions, their total charge is  $6 \times (-1) = -6$ .

The charge balance equation for the complex ion  $[\text{PtCl}_6]^{2-}$  is:



$$x + 6(-1) = -2$$

Simplifying, we get:

$$x - 6 = -2$$

Adding 6 to both sides:

$$x = 4$$

Therefore, the oxidation state of platinum in  $[\text{PtCl}_6]^{2-}$  is +4.

**Option C: +4**

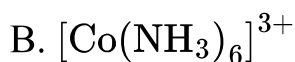
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## Question 8

Which of the following will have a spin only magnetic moment of 2.86 BM ?

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**Options:**



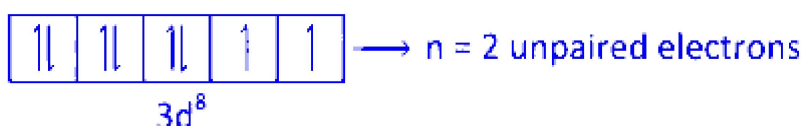
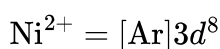
**Answer: C**

**Solution:**

For the compound  $[\text{NiCl}_4]^{2-}$

$\text{Cl}^-$  is a weak ligand.

Central metal atom has +2 oxidation state.



Magnetic moment is given by

$$\mu_s = \sqrt{n(n+2)}\text{BM}$$

$$\Rightarrow \mu_s = \sqrt{2(2+2)}\text{BM}$$

$$\approx 2.86\text{BM}$$

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## Question9

The molecular formula of a coordinate complex is  $\text{CoH}_{12}\text{O}_6\text{Cl}_3$ . When one mole of this aqueous solution of complex is reacted with excess of aqueous  $\text{AgNO}_3$  solution, three moles of  $\text{AgCl}$  was formed. What is the correct formula of the complex ?

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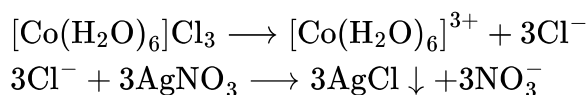
Options:

- A.  $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$
- B.  $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}_1\text{Cl}_2\text{H}_2\text{O}]$
- C.  $[\text{Co}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}(\text{H}_2\text{O})_2$
- D.  $[\text{Co}(\text{H}_2\text{O})_3\text{Cl}_3](\text{H}_2\text{O})_3$

**Answer: A**

**Solution:**

The complete reaction is as follows,



When one mole of  $\text{CoH}_{12}\text{O}_6\text{Cl}_3$  is treated with excess of  $\text{AgNO}_3$ , 3 mole of  $\text{AgCl}$  are obtained. It means that  $\text{CoCl}_3\text{H}_{12}\text{O}_6$  on dissociation in aqueous solution, all three chloride ions come in solution.

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## Question10

Identify the incorrect match from the following.



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## Options:

A.  $[\text{Cr}(\text{H}_2\text{O})_6]\text{Br}_2$  - Paramagnetic

B.  $\text{Na}_4[\text{Fe}(\text{CN})_6]$  - Diamagnetic

C.  $[\text{Ni}(\text{CO})_4]$  - Paramagnetic

D.  $\text{Na}_2[\text{NiCl}_4]$  - Paramagnetic

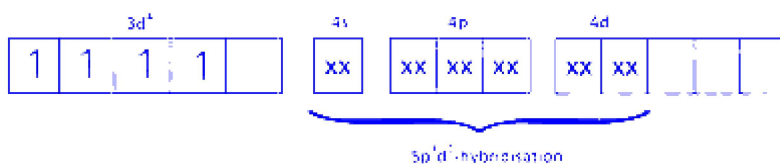
**Answer: C**

## Solution:

In  $[\text{Cr}(\text{H}_2\text{O})_6]\text{Br}_2$ , oxidation state of Cr is +2

The electronic configuration of  $\text{Cr}^{2+} = [\text{Ar}], 3d^4 4s^0 4p^0 4d^0$

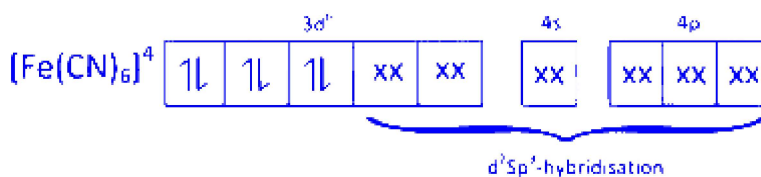
$[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$



Since, there are four unpaired electrons, thus the complex would be paramagnetic.

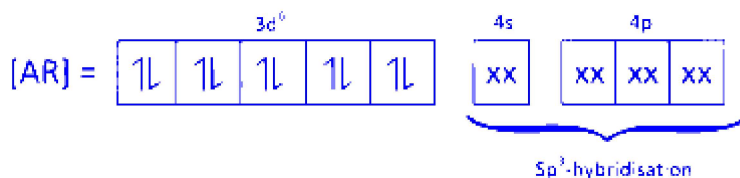
In  $\text{Na}_4[\text{Fe}(\text{CN})_6]$  oxidation state of Fe is +2

$\text{Fe}^{2+} = [\text{Ar}], 3d^6, 4s^0, 4p^0$



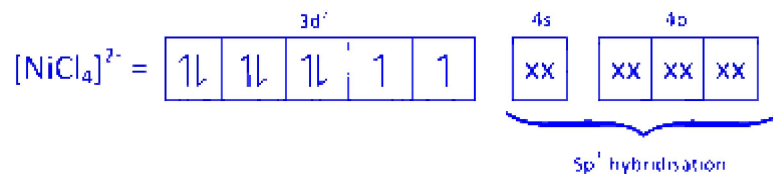
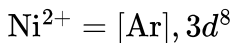
No unpaired electrons are there. Thus the complex will be diamagnetic. In  $[\text{Ni}(\text{CO})_4]$  oxidation state of Ni is 0.

$\text{Ni}^0 = [\text{Ar}], 3d^8$



No unpaired electrons are there. Thus the complex will be diamagnetic.

In  $\text{Na}_2[\text{NiCl}_4]$  oxidation state of Ni is +2



Since, there are 2 unpaired electrons. Thus, the complex is paramagnetic. Thus, the incorrect match is  $[\text{Ni}(\text{CO})_4]$  paramagnetic.

## Question 11

Match the following.

List-I (Complex)	List-II (Electronic configuration of metal/ion)
(A) $[\text{Co}(\text{NH}_3)_6]^{3+}$	I. $t_{2g}^5 e_g^0$
(B) $[\text{CoF}_6]^{3-}$	II. $t_{2g}^6 e_g^0$
(C) $[\text{Ni}(\text{CO})_4]$	III. $t_{2g}^4 e_g^2$
(D) $[\text{Fe}(\text{CN})_6]^{3-}$	IV. $t_{2g}^4 e_g^6$

The correct answer is Table

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Options:

A. A-II, B-III, C-IV, D-I

B. A-III, B-IV, C-II, D-I

C. A-IV, B-III, C-I, D-II

D. A-II, B-I, C-IV, D-III

**Answer: A**

**Solution:**

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(Complex)	(Electronic configuration of metal/ion)
A. $[\text{Co}(\text{NH}_3)_6]^{3+}$	II. $t_{2g}^6 e_g^0$
B. $[\text{CoF}_6]^{3-}$	III. $t_{2g}^4 e_g^2$
C. $[\text{Ni}(\text{CO})_4]$	IV. $t_{2g}^6 e_g^0$
D. $[\text{Fe}(\text{CN})_6]^{3-}$	I. $t_{2g}^5 e_g^0$

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